

SPECIAL SPECIFICATION

SECTION 15622S

WATER-COOLED CENTRIFUGAL CHILLERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Packaged water chillers utilizing centrifugal compressor and water cooled condenser, with refrigerant, oil, charging, and start-up supervision; including:
 - 1. Complete chiller package including compressor, motor, drive, evaporator and condenser.
 - 2. Refrigerant piping.
 - 3. Charge of refrigerant and oil.
 - 4. Controls and control panel.
 - 5. Chilled water connections.
 - 6. Condenser water connections.
 - 7. Auxiliary water connections.
 - 8. Purge unit.
 - 9. Motor control panel including disconnect and starters.
 - 10. Electrical power connections.
 - 11. Isolators.

1.02 RELATED SECTIONS

- A. Section 13085 – Seismic Protection
- B. Section 15060S - Hangers and Supports.
- C. Section 15070S - Vibration Isolation.
- D. Section 15170S - Motors
- E. Section 15183S - Hydronic Piping and Specialties.

- F. Section 15083S – Pipe and Equipment Insulation.
- G. Section 15641S - Induced Draft Cooling Tower.
- H. Section 15950S - Testing, Adjusting and Balancing.

1.03 REFERENCES

- A. ANSI B9.1/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- B. ASHRAE 90A - Energy Conservation in New Building Design.
- C. ASME SEC 8 - Boiler and Pressure Vessel Code.
- D. UL 465 - Central Cooling Air Conditioners.
- E. ARI 550 - Centrifugal or Rotary Water - Chilling Packages.
- F. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. Include shop drawings for mechanical room showing all equipment and piping.
- B. Include product data indicating all components, assembly, dimensions, operating weights and loadings, required clearances and location and size of field connections. Indicate equipment, auxiliary support requirements, piping and connections, valves, strainers and thermostatic valves required for a complete system.
- C. Indicate on product data all rated capacities, specialties and accessories, electrical requirements and wiring diagrams.
- D. Include performance data indicating energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperatures.
- E. Include certified factory test reports prior to installation showing that horizontal or vertical vibration at any bearing does not exceed 1.0 mil.
- F. Provide operation and maintenance manual.
 - 1. Written listing of limiting conditions of chiller including minimum permissible temperatures, minimum voltages, maximum and minimum permitted ambient conditions, maximum

permitted chiller-water-entering temperature and recommended thermal shock and change-over temperatures.

2. Report signed by chiller manufacturer's representative indicating that work has been properly installed in accordance with manufacturer's written instructions.
3. Tool kit, including manufacturer's special tools and non-standard wrenches, required for servicing chiller.
4. Provide interlock control diagrams to provide the operation specified.

5. Provide control drawing including software points.

1.05 QUALITY ASSURANCE

- A. Provide A/E with manufacturer's certification that materials meet or exceed minimum requirements as specified.
- B. Regulatory Requirements
 1. Conform to ARI 550/**590-98** code for testing and rating of centrifugal chillers.
 2. Conform to UL 465 code for construction of centrifugal chillers and provide UL label.
 3. Conform to ASME SEC 8, Boiler and Pressure Vessel Code, for construction and testing of centrifugal chillers.
 4. Conform to ASHRAE 15 code for construction and operation of centrifugal chillers.

1.06 HANDLING AND EQUIPMENT ROOM REQUIREMENTS

- A. Comply with manufacturer's installation instructions for rigging, unloading and transporting units.
- B. Protect units from physical damage. Leave factory covers in place until installation.

1.07 EQUIPMENT ROOM REQUIREMENTS

- A. Follow minimum standards for refrigeration systems as required by BSR/ASHRAE 15 paying special attention to requirements for air monitoring, ventilation and self-contained breathing apparatus.
- B. Install a refrigerant monitor that can be calibrated for any refrigerant, capable of detecting concentrations in 1 ppm for low level leak detection and for insuring the safety of operators.

- C. Install suitable alarms that activate well below acceptable exposure level (AEL) of the refrigerant and alert persons inside and outside of the equipment room that a leak condition exists.
- D. Install local exhaust at relief valve discharge headers and purge units. Route exhaust to the exterior and away from all air intakes.

1.08 VERIFICATION OF CAPACITY AND EFFICIENCY

- A. Factory performance test **each** chiller with the proposed alternative refrigerant **at 25%, 50%, 75% and 100%** load conditions **with zero (0) tolerance** in an ARI certified test facility. Supply a certified test report to confirm performance as specified. Make proper ARI certification documents for the test loop available upon request from the manufacturer for inspection. Conduct the performance test in accordance with ARI Standard 550/590-98 procedures and tolerances.
- B. Demonstrate stable operation at a minimum load of 10 percent during the factory performance test with constant entering condenser water temperature. Modify the machine to include hot gas bypass if the minimum load cannot be demonstrated.
- C. Include ARI-approved selection method in proposals for chiller performance for acceptable refrigerant. Verification of date and version of computer program selection or catalog is available through the Vice President, Engineering, ARI (703) 524-8800.
- D. Run the performance test with clean tubes in accordance with ARI 550/590-98 to include the following:
 - 1. Make a downward temperature adjustment per Section A7.3 to the design leaving evaporator water temperature to adjust from the "design fouling" to the "clean tube" condition.
 - 2. Make an upward temperature adjustment per Section A7.3 to the design entering condenser water temperature to adjust from the "design fouling" to the "clean tube" condition.
 - 3. Conduct the performance test with clean tubes and with temperature adjustments in (1) and (2) above without exception. Have the manufacturer clean tubes, if necessary, prior to test to obtain a test fouling factor of .0000 hour square feet F/BTU.
 - 4. Provide factory test instrumentation per ARI Standard 550/590-98, and calibration of all instrumentation traceable to the National Institute of Standards and Technology (formerly NBS).
- E. Notify the Owner or his representative 14 days in advance to witness the factory performance test. If the owner or his representative **and engineer** witness the performance test, all travel expenses will be the **manufacturer's** responsibility.

- F. Submit a certified test report of all data to the Contracting Officer prior to completion of the project. Provide the factory certified test report signed by an officer of the manufacturer's company. Preprinted certification will not be acceptable; certification shall be original.
- G. The equipment will be accepted if the test procedures and results are in conformance with ARI Standard 550/590-98. If the equipment fails to perform within **zero (0)** tolerances, the manufacturer will be allowed to make necessary revisions to his equipment and retest as required. The manufacturer shall assume all expenses incurred by the owner or his representative to witness the retest. In the event that these revisions do not achieve submitted performance, the following penalties will be imposed:
1. Capacity Test:
 - a. For each ton below the allowable capacity as set forth in ARI 550/590-98 of the design capacity, \$1,000.00 (one thousand dollars) per ton will be deducted from the contract price.
 - b. Allowable capacity = $[(1 - \text{tolerance}) \times \text{design capacity}]$; tolerance per ARI **550/590-98**, Section 5.4.
 2. Power Consumption Test:
 - a. The power consumption penalty for all load points shall be based upon the tolerances set forth in ARI **550/590-98**. The power consumption penalty (P.C.P.) will be calculated based upon the following formula:
 - b. $\text{P.C.P.} = [\text{Measured KW} - (\text{Measured Tons} \times \text{Allowable KW/Ton}^*)]$ by \$2,000/KW.
 - c. $^*\text{Allowable KW/Ton} = [(1 + \text{tolerance}) \times \text{design KW/Ton}]$; tolerance per ARI 550-90, Section 5.4.
 3. Total Performance Penalty: The total performance penalty will be the sum of the capacity penalty and the power consumption penalty times the number of typical chillers, regardless if tested.
- H. Equipment manufacturer's invoice will not be acceptable for centrifugal chiller(s) until successful completion of the performance test or acceptance of the penalty deduction from the contract.

1.09 SOUND

A. Sound Data:

1. The centrifugal chiller Sound Pressure Level (SPL), in decibels (dB), with a reference pressure of 20 micropascals, shall not exceed the values listed below. All ratings shall be

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in accordance with ARI Standard 575-87, "Method of Measuring Machinery Sound Within Equipment Rooms."

2. No reduction of entering condenser water or raising of leaving chilled water temperatures will be allowed in the SPL's. Making such a temperature adjustment does not represent the loudest operating condition the chiller will experience while on the job, and could mask sound problems that would otherwise occur. A minimum of 75 percent of the sound data points along the length of the machine shall be taken, and established as the minimum percentage of total possible points used to determine sound levels.

| % Load | dB, A Weighted |
|---------------|-----------------------|
| 100 | 84 |
| 50 (optional) | 85 |
| 25 (optional) | 87 |

- B. The specific chiller meets the referenced noise criteria above. If the contractor chooses to use another manufacturer, the contractor is responsible for any and all field modifications to meet this criteria. If other than the specified chiller is used, the contractor must conduct a sound measurement test in accordance with ARI 575-87 to demonstrate compliance to the above specified values. Any field modifications (sound attenuation) that are required in order to reduce sound levels to those specified must be followed by an additional sound measurement test. No payment will be made to the contractor until the sound analysis is complete, verifies compliance to the specified values, and is deemed acceptable by Owner.

1.10 WARRANTY

- A. Provide a one year warranty for parts, labor and refrigeration from date of issuance of occupancy permit. Warranty to coincide with manufacturer's parts warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Trane.
- B. York.

2.02 GENERAL

- A. Provide factory-assembled and tested, packaged, water cooled, liquid chillers consisting of centrifugal compressor, compressor motor, condenser, evaporator, purge unit, refrigeration accessories, instrument and control panel including gages and indicating lights, auxiliary components and accessories, and motor starters. Construct and rate units in accordance with ARI Standard 550/590-98.
- B. Provide units with **NPLV** not less than prescribed **in equipment schedules**.
- C. Provide centrifugal water chillers having minimum capacity as scheduled on the drawings, and capable of producing the scheduled leaving water temperature at design conditions. Base capacity of units on a fouling factor of .00025 for cooler and condenser.

2.03 COMPRESSORS

- A. Compressor Casing: Fine grain, cast iron, horizontally or vertically split, with machined passages. Seal casing joints against leakage with gaskets. Provide sight glass for monitoring compressor rotation.
- B. Impellers: Single or multi-stage, in-line design, fully shrouded, statically and dynamically balanced, over-speed tested to 20 percent over operating speed, cast high strength aluminum alloy mounted on heat treated forged steel shaft, non-ferrous, labyrinth seals between stages.
- C. Guide Vanes: Modulating radial blade dampers on each stage, with externally mounted electric operator, suitable for capacity reduction to 10 percent of specified load without surge, cavitation vibration or hot gas bypass when supplied with design entering water quantity and design temperature entering condenser water.
- D. Bearings: Babbitt lined sleeve bearings, self aligning, pressure lubricated.
- E. Provide gear box that is an integral part of the compressor and lubricated through the compressor lubrication system, of the double helical design, symmetrical and center supported by spherically seated, self aligning bearing, arranged for inspection without disassembly. Minimum of 1.2 service factor.
- F. Motor: Hermetically sealed or open drive, suction or liquid refrigerant cooled, single speed, low slip induction type suitable for operation at 3,600 rotations per minute. Correct power factor to 0.95 at full load. Provide motor terminations to accept compression fittings without field modification. Mechanical set screw or bolt type lug wiring connection will not be acceptable for termination.

1. Provide an oil reservoir to collect any oil and refrigerant that leaks past the seal.
 2. Provide a float device to open when reservoir is full, directing the refrigerant/oil mixture back into the compressor housing.
 3. Provide a manufacturer's warranty to protect the shaft seal, reservoir and float valve system against leakage of oil and refrigerant to the outside of the chiller for a period of 5 years from initial start-up, including parts and labor to replace a defective seal and any refrigerant required to trim the charge to original specifications. Inspections shall be performed on at least an annual basis.
- G. Units with speed increasing transmissions shall not exceed 10,000 rotations per minute compressor speed and shall annually inspect the gears and bearings. A report shall be forwarded to the owner each year over the first five years to confirm completion.
- H. Lubrication: Direct drive, positive displacement oil pump with oil cooler, pressure regulator, oil filters, thermostatically controlled oil heater and motor controls for 1/4 horsepower motor. Interlock to start before chiller motor and run after motor is shut down. Provide sight glass for monitoring oil level.
- I. Provide refrigerant isolation valves on both sides of the oil filter to allow oil filter changes without opening refrigeration system to the atmosphere. Replace the initial oil filter after a maximum of 100 hours of operation or less if recommended by the manufacturer.
- J. Provide a liquid line angle type filter dryer with replaceable core and jet pump (ejector) system. Install complete with bronze jet pump, shutoff valves, relief valves, moisture indicators, insulation, distillation storage tank with integral legs and interconnection piping, in accordance with Sporlan Bulletin 240-10-3. Provide blow-off valve on bottom of distillation tank for removal of system contaminants.
- K. Run test each assembled compressor motor (transmission) at the factory and provide certified test results as called for in submittals.

2.04 REFRIGERANT

- A. Refrigerants on which chiller performance are based:
1. HCFC-123.
 2. HCF-134a.

2.05 EVAPORATOR

- A. Provide evaporator of shell and tube type, seamless or welded steel construction, with cast iron or fabricated steel heads, integrally finned seamless copper tubes either smooth bore or internally enhanced, rolled or silver brazed into tube sheets. Space tube support sheets approximately 2.5 feet.
- B. Design, test and stamp refrigerant and water side for 150 percent of the maximum design working pressure in accordance with ASME SEC 8.
- C. Provide removable marine type water boxes, machine welded to heat exchanger, with tapped drain and vent connections, and flanged or mechanical joint connections arranged to permit inspection of tubes from either end without disturbing refrigerant and removable without disturbing water piping.
- D. Factory insulate evaporator surfaces and all other cold surfaces with two layers of 3/4-inch minimum thick flexible **closed cell** insulation with maximum 'k' value of 0.28. Apply insulation so that all joints are staggered and no surface capable of causing condensation is uninsulated. Finish insulation with two coats of vinyl lacquer coating.
- E. Provide thermometer wells for temperature controller and low temperature cutout.
- F. Provide refrigerant chambers with baffles to distribute entering liquid and separate liquid from leaving gas.
- G. Provide carbon rupture disc on shell in accordance with ASHRAE 15.
- H. Provide evaporator suitable for circulation of the scheduled fluid quantities; with scheduled pressure drops from inlet to outlet, including water heads as indicated; with sufficient eliminator area or other means to prevent liquid refrigerant carry-over into compressor; and with a minimum water-side tube-temperature of 33-1/2 degrees F.
- I. Provide construction and materials conforming to ANSI B9.1 and ASME SEC 8.

2.06 CONDENSERS

- A. Provide condensers of shell and tube type, seamless or welded steel construction, with cast iron or fabricated steel heads, integrally finned seamless copper tubes either smooth bore or internally enhanced, rolled or silver brazed into tube sheets. Space tube support sheets approximately 2.5 feet. Provide additional condensers on heat recovery units.

- B. Design, test and stamp refrigerant and water side for 150 percent of the maximum design working pressure in accordance with ASME Section 8.
- C. Provide removable marine type water boxes, machine welded to heat exchanger, with tapped drain and vent connections and flanged or mechanical joint connections arranged to permit inspection of tubes from either end without disturbing refrigerant, and removable without disturbing water piping.
- D. Provide carbon rupture disc on shell in accordance with ASHRAE 15.
- E. Provide baffles to ensure even distribution of incoming gas and to concentrate non-condensable gases.
- F. Construction and materials shall conform to ASME SEC 8.

2.07 PURGE SYSTEM

- A. The manufacturers of low pressure machines, must provide a separate compressor type purge system.
- B. Operate the purge independently of the chiller and while the machine circulation water pump is shut down. No external water cooling source is to be required.
- C. Provide a positive pressure device (such as a belly heater) on the evaporator to raise the pressure of the bundle above atmospheric pressure when the machine is off, if the purge unit cannot operate when the machine and pump are off. This will prevent non-condensables from entering the machine. Include the additional power draw of this device in the quoted machine efficiency.
- D. Any excess purge requirement will enable a fault indication light at the purge. Provide a contact closure for remote annunciation.
- E. Unit Indication:
 - 1. Lights indicating condenser running, fault indication and service operation.
 - 2. Elapsed time meter (monitor amount of leak rate).
 - 3. Binary outputs to indicate purging of air from the purge unit and purge shutdown due to excessive operation.

- F. Rate the purge for no more than 1 pound of refrigerant per 1 pound of non-condensable gas at standard operating conditions and with a condensing refrigerant temperature greater than 80 degrees F.

2.08 PUMP-OUT SYSTEM

- A. Provide the capability of storing the entire refrigerant charge in the condenser or provide a pump-out system with transfer pump, **and** condensing unit.
- B. Pump-out systems shall be supplied and warranted by the chiller manufacturer.

2.10 CONTROLS

- A. On or near chillers, mount steel control panel containing solid state, fully automatic operating and safety controls. Control the chiller(s) by a stand-alone Direct Digital Control (DDC) System. Provide a dedicated chiller control panel with each chiller by the chiller manufacturer. Provide a microprocessor-based panel with factory packaging and testing of all required control components for reliable equipment operation.
- B. Via the chiller control panel provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches. Provide a complete system for stand-alone chiller control within the panel and include controls to safely and efficiently operate the chiller.
- C. **Control and/or Monitor:**
 - 1. Start/Stop Chillers (Control)**
 - 2. Load/Unload Chillers (Control)**
 - 3. Temperature Reset (Control)**
 - 4. Monitor Chiller Safeties**
 - 5. Monitor Chiller Performance**
 - 6. Control Panels must be able to allow FCS hardwiring to terminal to do above.**
 - 7. Control panels must be compatible with a Siemens Building Control System using apogee.**
- D. Provide factory installed temperature sensors installed in the oil return lines of each motor bearing (including high speed, low speed, and thrust bearings) to monitor bearing

temperatures. If any oil temperature reaches or exceeds a set value, shut down the chiller operator from the chiller control panel and display the diagnostic.

- E. Incorporate advanced motor protection to protect the motor throughout the starting and running cycles from the adverse affects of:
 - 1. Phase loss.
 - 2. Phase imbalance.
 - 3. Phase reversal.
 - 4. Phase loss/failure.
 - 5. Low voltage.
 - 6. Distribution of fault protection with auto restart consisting of three phase, current sensing devices that monitor the status of the current.
- F. Provide a demand limit device to manually set maximum current infinitely between 20 percent and 100 percent of full load amperes.
- G. Provide the following displays on the front of the chiller control panel:
 - 1. Entering and leaving evaporator water temperature.
 - 2. Entering and leaving condenser water temperature.
 - 3. Chilled water setpoint.
 - 4. Electrical current limit set point.
 - 5. Chiller operating mode.
 - 6. Chiller diagnostic codes.
 - 7. Evaporator refrigerant pressure.**
 - 8. Condenser refrigerant pressure.**
- H. Provide the chiller control panel with evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of chiller operation. The control shall take progressively more aggressive load limiting action in response to the severity of the rate of change and the actual value of the evaporator refrigerant temperature. Automatically display a diagnostic code, reflecting the operating status, at the front panel whenever this control is in effect.

I. Total FCS Interface: The chiller manufacturer shall provide all necessary control panels to provide an FLN interface so that the FCS system can read each monitored point of the chiller control panels. The chiller manufacturer shall terminate wires at the control panels and shall commission and verify FLN compliance of the interface between the chiller and the controls contractor. Each chiller will be connected directly to the FLN communication bus. Where required, the chiller manufacturer will provide the necessary integrator, and programming to allow each chiller to communicate directly to the FLN communications network.

J. Refrigerant Monitor:

1. Models:

a. General Analysis Corporation, LAN Ia.

b. Approve alternate sensors prior to bid and meet the following criteria:

- (1) Provide the capability of detecting, alarming and controlling from 0 to 50 pounds per minute. Provide digital display accuracy within 1 pounds per minute.
- (2) Minimum Maintenance: Recalibration required no more than once every five years and rezeroing no more than once every week.
- (3) Capable of operation in ambient temperatures from 40 degrees F to 105 degrees F.
- (4) Outputs to include two analog and three binary with individual closure setpoints.

K. The above specified items are required as a minimum. The contractor may select which items are covered by the equipment supplier and which are covered by the controls contractor. A combined submittal will be required where the contractor will identify which items are covered by each supplier.

2.11 SOLID STATE STARTER (where required)

A. X-Line solid-state type motor starter operable to 120 degrees F.

B. Provide isolating switch and contactor assemblies, including current limiting fuses of the component-to-component design without any interconnecting cables or flexible shunts and easily removed from the front of the enclosure. Provide line and load cable terminations completely accessible from the front.

- C. Provide an externally operated manual three pole draw-out isolating switch such that in the open position it completely grounds and isolates the starter from the line connectors with a mechanically driven isolating shutter leaving no exposed high voltage. Provide integral mechanical interlocks to prevent entry into the high voltage areas while the starter is energized and to block accidental opening or closing of the isolating switch when the door is open or contractor is closed. Provide the isolating switch handle with provisions for three padlocks.**
- D. Provide current limiting power fuses of the self-protecting type with visible fuse condition indicators, and with special time/current characteristics for motor service allowing proper coordination with the contractor and overload protection for maximum motor protection. Vertically mount the power fuses permitting easy inspection and replacement without starter disassembly.**
- E. Isolate the low voltage control by a barrier from the high voltage area and provide with a separate low voltage access door. Provide accessibility into the low voltage panel by sliding the unit out.**
- F. Provide enclosures for the high voltage starters meeting NEMA ICS-6 enclosure standards, NEMA 1, unless otherwise noted. Provide complete front accessibility and allow free-standing against a wall or back-to-back mounting. Where multiple starter/structure installations are required, horizontal power bus should be used to connect between structures located on the top. Vertical bus to connect tiered starter units shall be insulated and integral to the enclosure.**
- G. Provide an advanced motor protection system incorporating electronic three phase overloads and current transformers. Monitor and protect against the following conditions:**
 - a. Three phase overload protection.**
 - b. Overload protection during start-up.**
 - c. Phase imbalance.**
 - d. Phase loss.**
 - e. Phase reversal.**
 - f. Low voltage.**
 - g. Provide distribution fault protection with auto restart consisting of three-phase, current sensing devices that monitor the status of the current. Detect distribution faults of 1-1/2 electrical cycle durations and disconnect the compressor motor within six electrical cycles.**
- H. Alternately the advanced motor protection system can be furnished in the chiller control panel.**
- I. Provide copper field supplied wires, bus bars and fittings.**

J. Provide the following starter options:

- a. Ammeter: Three ammeters, one per phase. Calibrate so the inrush current can be indicated.**
- b. Voltmeters: Three voltmeters, each reading a phase to phase voltage.**

2.12 VARIABLE SPEED DRIVE (where required)

- A. Manufacturer and installer of chiller/VSD package must have at least five years of experience.**
- B. Variable Speed Drive: A variable speed drive shall be factory supplied and installed on the chiller. It shall vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The package shall include adaptive capacity control logic to automatically adjust motor speed and compressor pre-rotation vane position independently. The control system shall provide maximum operating efficiency at all loads and water temperatures by analyzing information fed to it via sensors located throughout the chiller.**
- C. Drive shall be PWM type utilizing IGBT's with a power factor of 0.95 or better at all loads and speeds. Drives that do not provide power factor correction are not acceptable.**
- D. The variable speed drive shall be unit mounted in a NEMA-1 enclosure with all power and control wiring between the drive and chiller factory installed, including power to the chiller oil pump. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring shall be provided. The entire chiller/drive package shall be UL listed. To minimize motor peak voltages to within acceptable motor insulation design limits, motor lead length shall not exceed 48 inches.**
- E. The following features shall be provided:**
 - 1. A door interlocked circuit breaker, capable of being padlocked.**
 - 2. UL listed ground fault protection.**
 - 3. Overvoltage and undervoltage protection.**
 - 4. 3 phase sensing motor overcurrent protection.**
 - 5. Single phase protection.**
 - 6. Insensitive to phase rotation.**
 - 7. Overtemperature protection.**
 - 8. Digital readout at the chiller unit control panel of:**

- a. **Output Frequency.**
 - b. **Output voltage.**
 - c. **3 phase output current.**
 - d. **Input Kilowatts (kW) and Kilowatt-hours (KWh).**
 - e. **Self diagnostic service parameters.**
- F. Separate meters or displays on the drive for this information shall not be acceptable. All information shall be displayed at the chiller control panel, available for remote monitoring via a FCS connection.**
- G. Maximum chiller VSD percentage current TDD shall not exceed 30 percent. Manufacturer shall field install and warrant all harmonic mitigating devices required to obtain this level. Provide test data verifying compliance with these levels as part of the chiller submittal data.**

2.13 ELECTRICAL CONNECTION

- A. Provide single point of electrical connection for each chiller.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide for connection to electrical service.
- C. Provide for connection of electrical wiring between starter and chiller control panel, oil pump and purge unit.
- D. Align chiller on concrete foundations, sole plates and sub-bases. Level, grout and bolt in place.
- E. Provide vibration isolation between unit and structural support.
- F. Provide evaporator connections to chilled water piping. On inlet, provide thermometer well for temperature controller, thermometer well and thermometer, nipple and flow switch, flexible pipe connector, pressure gage and shut-off valve. On outlet, provide thermometer

well and thermometer, flexible pipe connector, pressure gage and shut-off or balancing valve as indicated on the drawings.

- G. Provide necessary auxiliary water piping for oil cooling units and purge condensers.
- H. Provide condenser connection to condenser water piping. On inlet, provide thermometer well for temperature limit controller, thermometer well and thermometer, nipple and flow switch, flexible pipe connector, pressure gage and shut-off valve. On outlet, provide thermometer well and thermometer, flexible pipe connector, pressure gage and shut-off or balancing valve as indicated on the drawings.
- I. Arrange piping for easy dismantling to permit tube cleaning.
- J. Provide piping from chiller rupture disc to outdoors. Size as recommended by manufacturer.
- K. Repair damages to factory finish (including insulation) up to time of acceptance by Owner.

3.02 MANUFACTURER'S FIELD SERVICES

- A. Provide services of a factory trained representative for two days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up and calibrate controls. Provide certification in writing that this work was accomplished.
- B. Supply initial charge of refrigerant and oil to fully charge the system, and leave it in complete and satisfactory operating condition. Replace all or any part of the refrigerant or oil charge that may be lost during the testing operations or warranty period.
- C. In addition to other services of factory trained representative, provide services of a factory trained representative for a period of one week, based on a 40-hour week, to instruct the Owner's operating personnel in the operations and service of the units. Provide certification in writing that this work has been accomplished.

END OF SECTION